Traffic Flow Characteristics

CIVL 4162/6162

(Traffic Engineering)

Lesson Objective

- Define microscopic traffic stream parameters
- Establish the relationship between traffic stream parameters
- Calculate and compute parameters with given data

Remainder

- Macroscopic traffic flow parameters
  - Volume
    - Rate of flow
    - AADT
    - AAWT
    - ADT
    - AWT
  - Speed
  - Density

Traffic Flow Basics-Summary (1)

Flow	Density
veh/hr	veh/mi
Measured over time at a fixed point	Measured over space at a fixed time
How many vehicles are getting somewhere?	How crowded is the roadway?
Can measure with a point detector	Can measure with an aerial photo
q	*k*

Traffic Flow Basics-Summary (1)

Individual vehicle	Traffic stream
Speed [L/T]	
	Flow [V/T]
	Density [V/L]

Traffic Flow Basics-Summary (3)

Classify the quantities

Individual vehicle	Traffic stream
Speed [L/T]	
	Flow [V/T]
	Density [V/L]

Brackets describe units… L = Length, T = time, V = vehicles

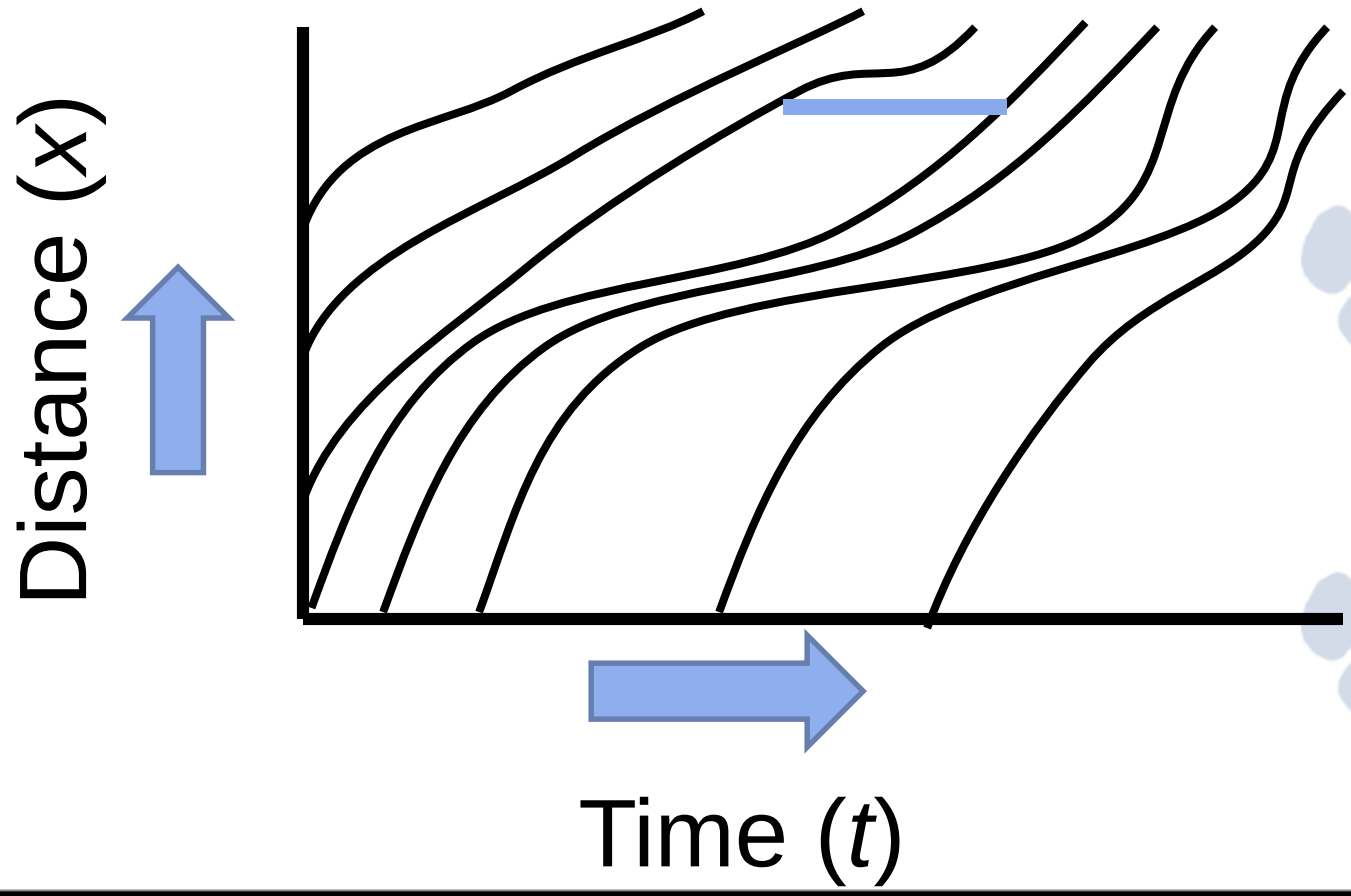
Traffic Flow Basics-Summary (4)

Let's try to fill in the rest of the table.

Individual vehicle	Traffic stream
Speed [L/T]	
Time Headway [T]	Flow [V/T]
	Density [V/L]

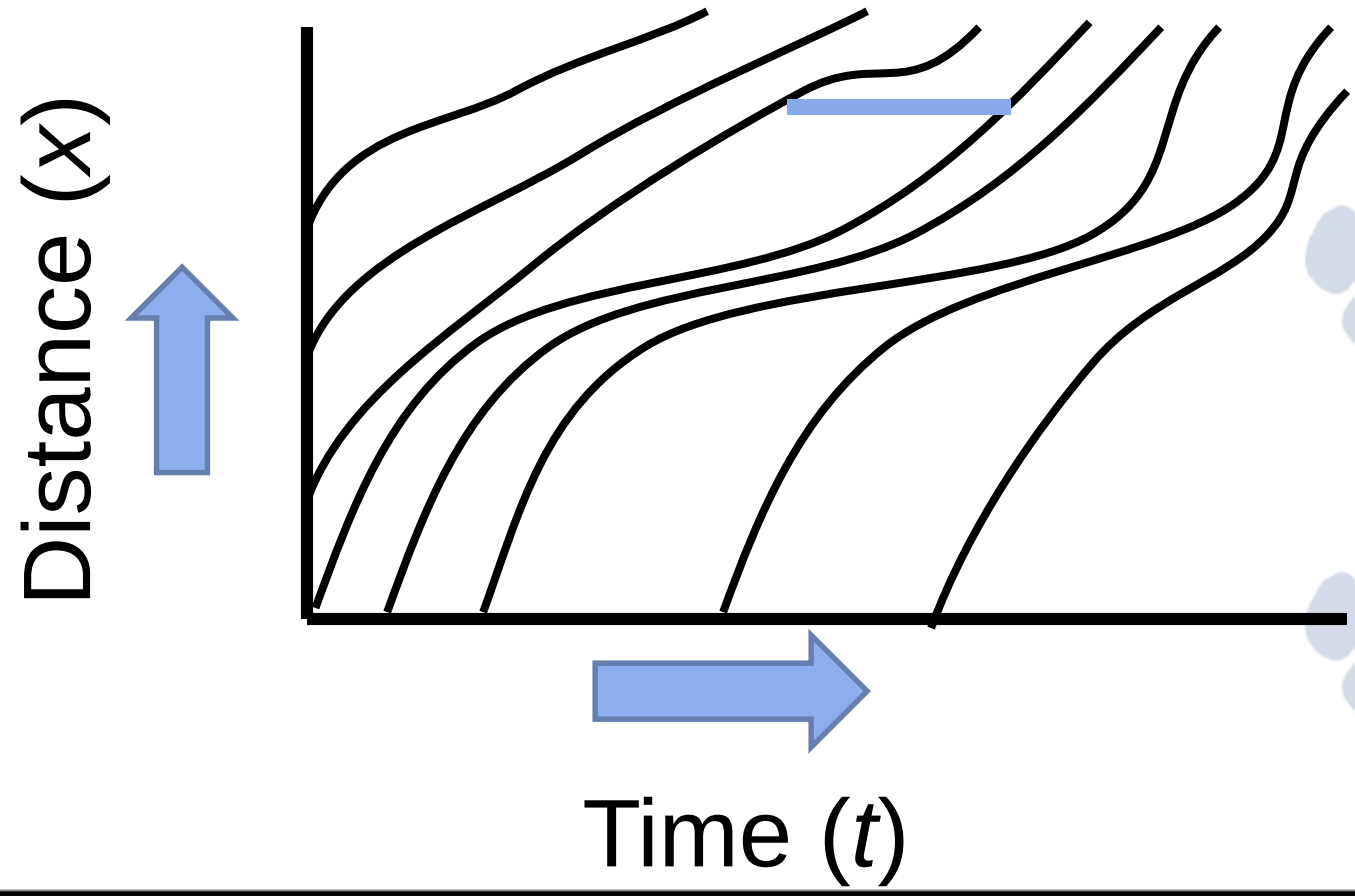
Traffic Flow Basics-Time Headway

The **time headway** is the time between two vehicles passing a point.



Traffic Flow Basics-Space Headway

On a space-time diagram, it is the **horizontal distance** between two adjacent trajectories



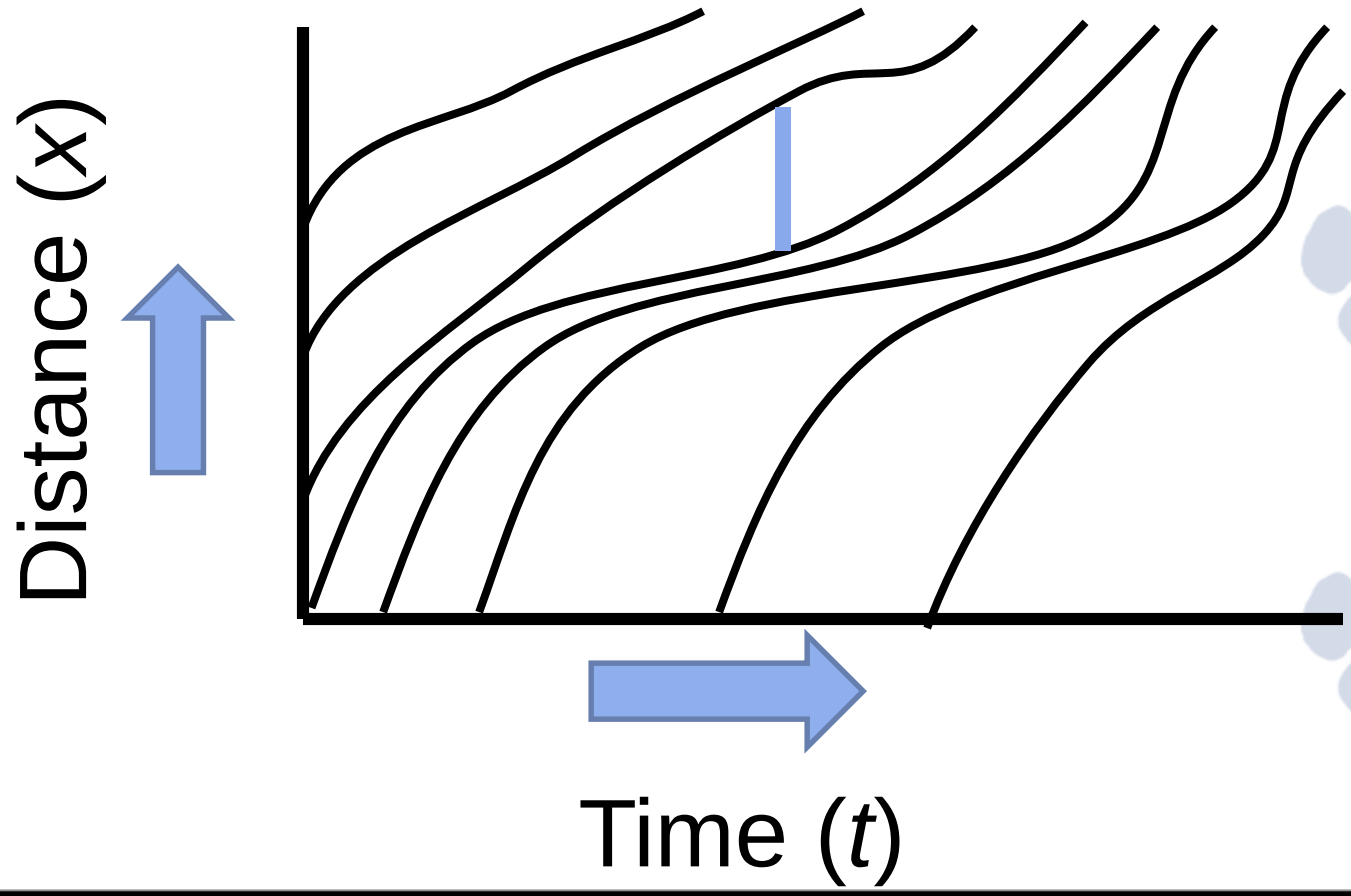
Traffic Flow Basics-Summary (5)

Let's try to fill in the rest of the table.

Individual vehicle	Traffic stream
Speed [L/T]	
Time Headway [T]	Flow [V/T]
Space Headway [L]	Density [V/L]

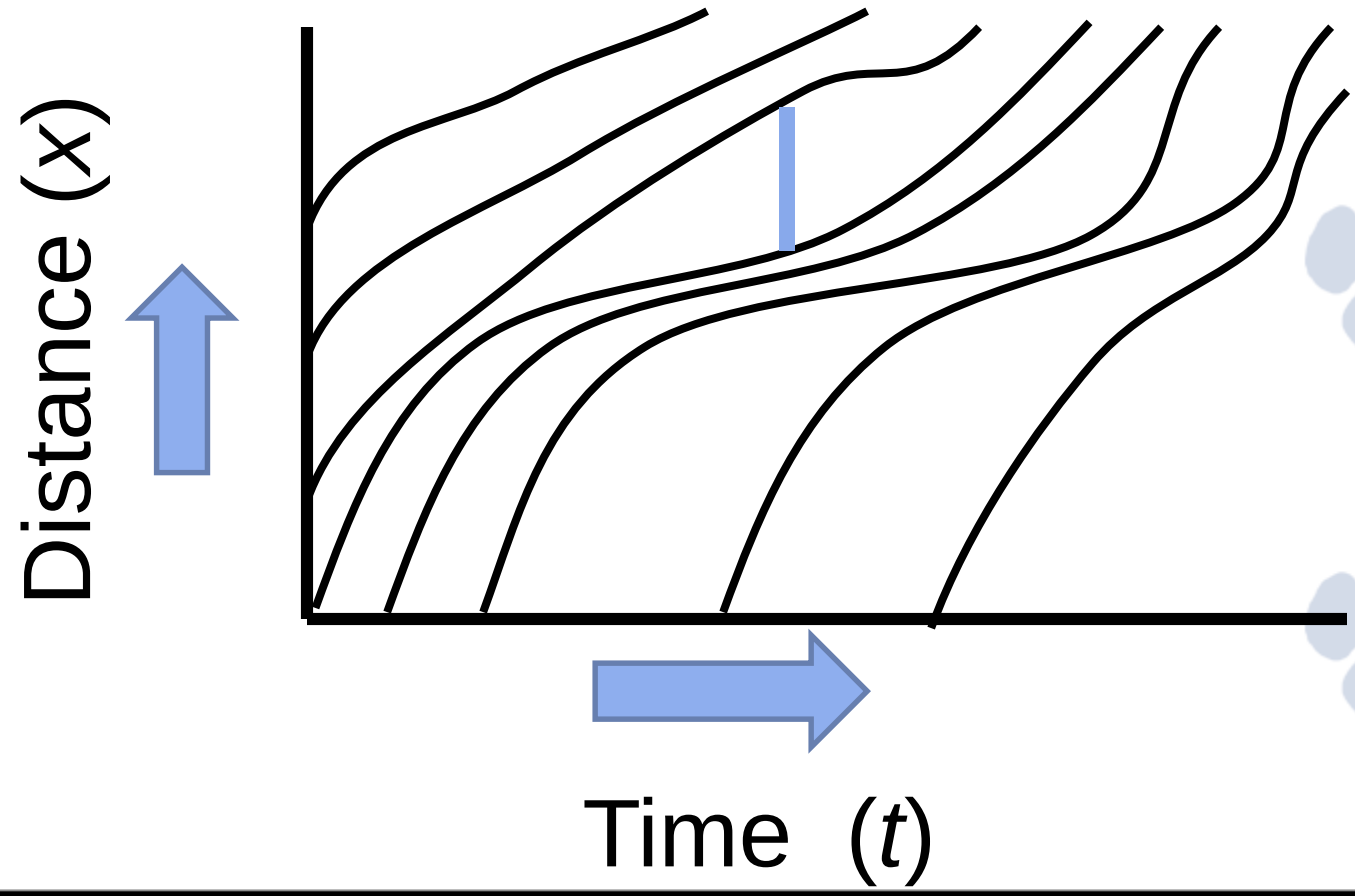
Traffic Flow Basics-Space Headway (1)

The **space headway** is the distance between two vehicles.



Traffic Flow Basics-Space Headway (2)

On a space-time diagram, it is the **vertical distance** between two adjacent trajectories



Traffic Flow Basics-Summary

Let's try to fill in the rest of the table.

Individual vehicle	Traffic stream
Speed [L/T]	Average Speed [L/T]
Time Headway [T]	Flow [V/T]
Space Headway [L]	Density [V/L]

Basic Equation for Uninterrupted Flow:

$q = ku \quad (v = SD \text{ in your book})$

$where:$

$q = flow\ rate, vph\ or\ veh/h/\ln$

$k = density, veh/mi\ or\ veh/mi/\ln$

$u = space\ mean\ speed, mph$

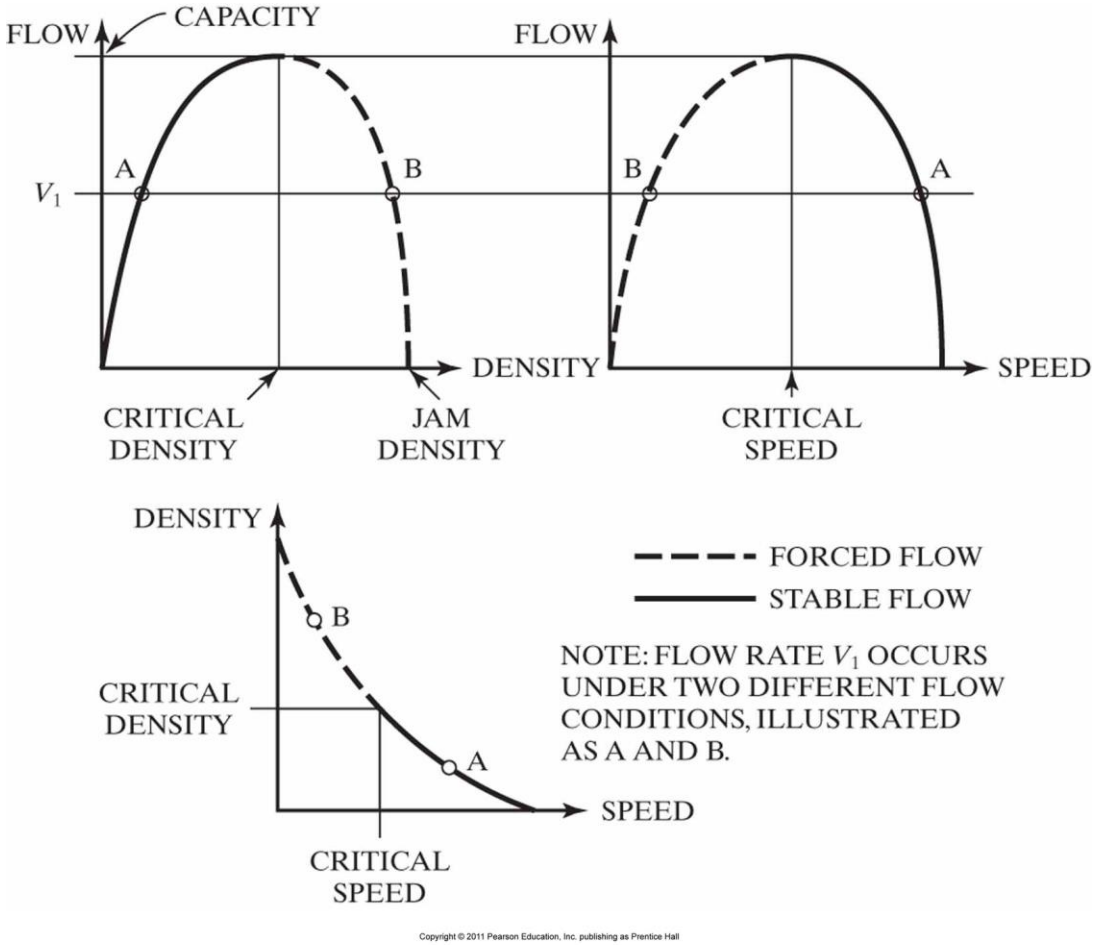
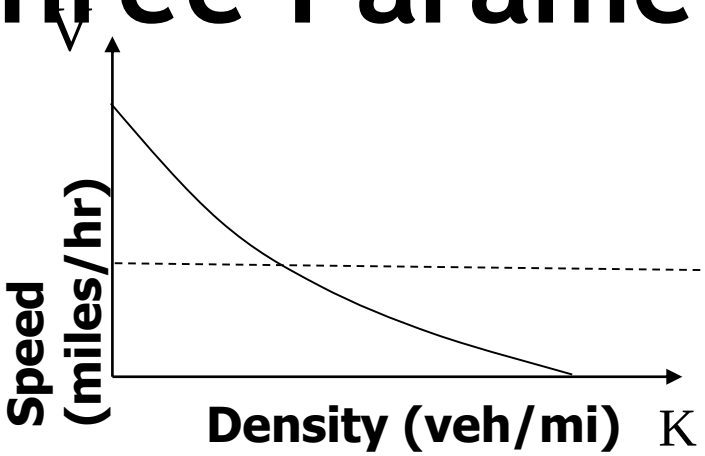
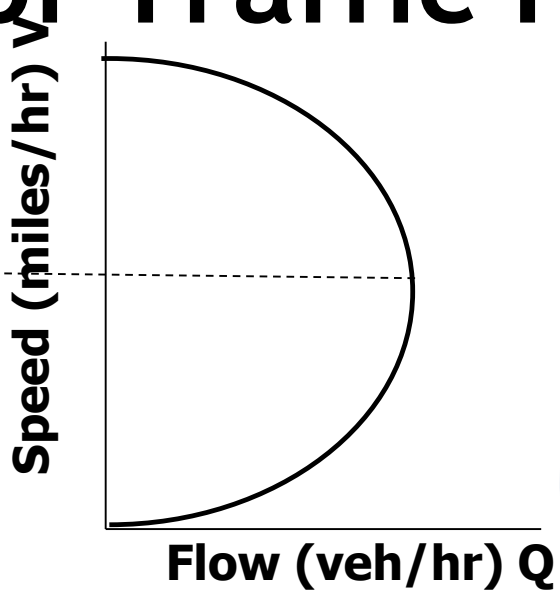
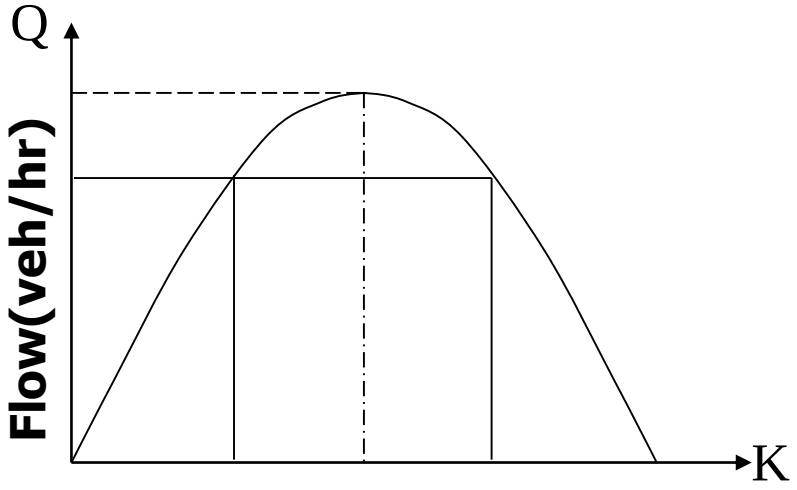


Figure 5.4 Relationships among Speed, Flow, and Density (*Source:* Used with permission of Transportation Research Board, National Research Council, from *Highway Capacity Manual*, 3rd Edition, *Special Report 209*, pp. 1–7, Washington DC, 1994.)

Three Parameters of Traffic Flow







- Macroscopic:
  - Speed (V)
  - Density (K)
  - Flow (Q)

    Q= KV

Spacing

- Spacing is defined as the distance between successive vehicles in a traffic lane; measured from common reference
  - Front bumper or
  - Front wheels
- Average spacing in a traffic lane is related to density

$$d_a = \frac{5{,}280}{k}$$

Where,
k = density in veh/mile/lane
$d_a = Average\ spacing\ between\ vehicles$ in ft

Headway

- Headway is defined as the time interval between successive vehicles as they pass along a lane
- Also measured between common point of reference

$$h_a = \frac{3{,}600}{q}$$

Where,
q = traffic volume in veh/hour/lane
$h_a = Average\ headway in\ the\ lane$ in sec

Example

- Traffic in an interstate at 7:15 AM is observed to have spacing of 250 feet; and average headway of 3 sec. Estimate
  - Volume
  - Density
  - Speed

Solution

Step1: Calculate flow

$$q = \frac{3{,}600}{h_a} = \frac{3{,}600}{3} = 1{,}200 \text{ veh/hour/lane}$$

Step-2: Calculate density

$$k = \frac{5{,}280}{d_a} = \frac{5{,}280}{250} = 21.12 \text{ veh/miile/lane}$$

Step-3: Calculate Speed

q = uk => u = q/k = 1200/21.12 = 56.81 miles/hour

Example

A study of freeway flow at a particular site has resulted in a calibrated speed-density relationship as follows: (Note the difference in notation)

$S = 57.5(1-0.008D)$

For this relationship, determine:

a. Free-flow speed
b. Jam density
c. Speed-flow relationship
d. Flow-density relationship
e. Capacity